CHAPTER 2

LITERATURE REVIEW AND THEORY

2.1. Literature Review

In this section will be explained about the relationship between researches conducted by the author with some previous research. This is done to obtain the renewal or *stage of the art* of this research.

2.1.1. Previous Research

P.W. Anggoro et al (2015) in the journal Procedia Engineering entitled *Reverse engineering technology in redesign process ceramics: application for CNN plate* using RE in changing profile and dimension of plate in PT. Doulton. The best material on CNN plate is Low Sag which is still in development stage while the standard piece of ceramic material is Bone China. In the process of making up to combustion using the same mold there is a difference in profiles and dimensions of the standard piece in the ream. P.W. Anggoro successfully use RE in overcoming the different profiles and dimensions to fit the standard pieces. Implementation of RE is done from the process of getting point cloud using CMM to redesign to get 2D CAD data to modify the mold.

Yahya Abdullahi et al (2015) in the journal "*Evolution of abstract vegetal ornaments in Islamic architecture*", investigates the history of abstract ornament of Islamic vegetation and sketches the evolution of its development to understand its creation and innovation process. Yahya also studied this ornament regionally and classified it according to customer's taste. Yahya analyzes the formal aspects of this ornament, including dimensions, proportions, dominant colors, materials, and techniques. And also in his journal, Yahya writes that in this century Relief Islamic much favored by upper middle class to decorate various buildings such as private house, mosque, restaurant, dome, tower, wall, and other buildings.

Chee Kai Chua et al (1997) in the journal Computer Aided Decoration of ceramic tableware. Part I: 3-D Decoration, talks about the use of Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) to process ceramic tableware. The author says that the use of computers in the ceramic tableware industry is largely limited to processing, spreadsheets, databases, payroll, inventory, and statistical process control. CAD / CAM is slowly starting to grow in this industry.

The relatively high speed to produce the physical design of conceptualization using CAD / CAM and Rapid Prototyping has suggested its use for decorating ceramic tableware. This system or more specifically, Computer Aided Decoration of Ceramic Tableware (CADOCT), was developed to design and create patterns to be decorated with ceramic tableware. A number of industry case studies featuring ceramic tableware prototypes were performed and presented to illustrate the advantages of using CADOCT prototype systems. Chua, et al (1997) also said that profits with this technology also include time and significant cost savings. This is to avoid a great dependence on traditional practices, and the experience and skills of craftsmen. The main contribution of this research is the innovative approach of art to a part or, from conceptualization to realization, to decorating ceramic tableware

Gunadi (2017) in her final assignment entitled "Analisis *Reverse Engineering* pada Ornamen *Islamic* di Industri Keramik Dinding (dari .JPG sampai RP Model)" using Reverse Engineering method to get various motifs of 2.5D ceramic tile characterized Batik Indonesia and included in Islamic Pattern category. The design process begins from the picture and is developed into surface of forming curve based on the vectors constructed from the picture. With ArtCAM software then enhancing 3D artistic model that is made based on the curve into 3D model ceramic tile according to the image and 2D vector image. The design result of Gunadi is very precise and got some master pattern of ceramic wall mold using 3D printer machine.

Wijayanto (2016) in the research "Aplikasi *Reverse Engineering* untuk Desain Ornamen Keramik Dinding Islamic Masjid Al-Huda" using conventional Reverse Engineering (RE) method with the assist of ArtCAM software to complete redesign process on ceramic tile product to speed up design process time, so that the production is not declining.

Narita. A. (2015) in the research " Aplikasi Adaptive Manufacturing Machine dan ArtCAM untuk Mengembangkan Variasi Produk Bros Berciri Khas Keraton Ngayogyakarta Hadiningrat (studi kasus CV. Tin's Ar)" has succeeded in getting one of the best brooch product designs from 7 designs. By using adaptive manufacturing machine technology in 3D Object 30Pro and combine with creative method to get product design variation. Software that helps the design process is ArtCAM 2013 and PowerSHAPE 2015.

Remmy (2017) in research on Reverse Engineering Approach from 3D meshes to 3D CAD / CAM in PT.Doulton sucessfully to get Miranda Keer Tea For One Teapot product that accurate, precise, efficient and fast compared to similar products in the market of ceramics world. To achieve these goals Remmy in his research using scanning tools Coordinate Measurement Machine (CMM) and 3D Scanner in PT. Doulton Indonesia to save time for RE process and calculate cost estimation and machining time.

2.1.2. Current Research

Based on the search of several international journals and final project reports from several researchers, a novelty was found about the lack or rarely attempted by some researchers to develop the design process of ceramic tableware with *Islamic* and Indonesian Batik nuance as an exclusive souvenir product.

Some researchers as Anggoro et al (2015), Chua et al (1997), Wijayanto (2016), Gunadi (2017), Remy (2017) have successfully applied the RE method with computer aided reverse engineering system technology for ceramic product (CARESystem_CP) but not all of them focus on ceramic tableware as a special souvenir.

Based on preliminary findings and observations result made by the authors and Ceramic Group Discussion Forum product show that most of the products of ceramic tableware sets produced by NPI are in plain model, only in coloring model. Products with Islamic characteristic have never been produced at all. Besides, it is also found in the field that to generate this product design idea to reality takes a very long time in NPI considering there is still a lot of usage of manual technology (handmade) by art designer owned by NPI.

RE successfully used by previous researchers also re-applied in this research to be able to generate the idea of early concept of ceramic dining set of tableware with Islamic and Indonesian Batik nuance from image sketch to become 3D CAD model and prototype of ceramic product processed by CNC machine or 3D printer.

To look the significant difference between the researchers did with some of the previous researchers can be presented in Table 2.1.

Tabel 2.1. Comparison Table

Name	Research Objectives	Research Objects	Method	Technology
Anggoro P.W. & Sujatmiko. I. I. (2015)	Find a new design that suits the characteristics of Low Sag Body	CNN Plate	Creative	Reverse Engineering CMM
Abdullahi. Y. & Embi. M. R. B (2015)	History of abstract Islamic vegetable ornaments and sketch their evolution to understand The process making and innovation	Islamic Ornaments	Rational	Reverse Engineering
Chee Kai Chua (1997)	Time and cost savings by using CAD / CAM technology on ceramic tableware production process	Ceramic Tableware	CAD/CAM Rapid Prototyping	Reverse Engineering
Wijayanto (2016)	How to implement CAD / CAM technology to produce wall ceramic with architecture Main Element Ornament Islamic Abstract in accordance with request of Al-Huda Jakarta Mosque as customer	Wall Ceramic Decoration	Creative	Reverse Engineering Rapid Prototyping

Tabel 2.1. Continuance of Comparison Table

Nama Peneliti	Tujuan Penalitian	Objek Penelitian	Metode	Teknologi
Narita. A. (2015)	Developing Variety Product of Typical Brooch of Ngayogyakarta Hadiningrat Palace	Brooch with Ngayogyakarta Hadiningrat Palace characteristic	Creative QFD	Adaptive Manufacturing
Gunadi (2017)	looking for optimal 3D design, so mold making process can be uplifted and when assembled the size of puzzle can be precision	Ceramic tile 3D	Creative	Reverse Engineering
Current Research (2018)	Applying Reverse Engineering method in process making set ceramic tableware products to speed up design process time	Set Ceramic Tableware	Brainstorming Creative Reverse Engineering Conventional	Reverse Engineering Rapid Prototyping

2.2. Theory

2.2.1. Ceramic

Ceramics (pottery) is one of the many oldest crafts in the world. In thousands of years ago ceramics were made by the Egyptians around the Nile. The word ceramic itself comes from the Greek word "keramos" which means a pot or a pot made from the ground (Ambar Astuti, 2008). While the meaning of goods / ceramic material is: all goods / materials made from soil materials / silicate rocks and the manufacturing process through combustion at high temperatures. Clay is the main ingredient of ceramic making and it is very beneficial for humans because the material is easy to obtain and its use is very diverse. In Indonesia, ceramics have been known since the Neolithic era, at 2500 BC-1000 BC. Humans at that time used ceramics for guns and pottery. The general nature of ceramics is brittle, this is found in traditional ceramics such as glass, jug, and pottery and so on. Other properties are resistant to high temperatures, ceramic clay, *flint*, and *feldfar* resistant to a temperature of 12000C while the oxide ceramic can last up to 20000C.

2.2.2. Tableware

Tableware is a form of object or equipment used as a dish and cutlery. The nature of tableware is fragile goods made of ceramic, porcelain, pottery, clay. In general the overall tableware can be clarified as follows:

i. Platter

   Is a plate with various sizes that is small, medium, and large. It has three shapes, there is an oval (oval platter), round (round platter) and rectangular (rectangular platter).

ii. Plates

- Dinner plate, which is a large flat dish used to serve the main course. 26 cm in diameter.
- Soup plate, is a sunken dish commonly used for daily home cooking or buffet purposes and for serving soup.
- Dessert plate, a plate of responsibility that is used to serve dessert, an appetizer and sometimes as an underliner or a base to serve dishes. The diameter of the dessert plate is 18 cm.
- B & B plate (Butter and Bread), which is used to serve bread and butter. Its diameter is about 15 cm.
- Fish plate, which is a dish to serve fish dishes.

- Breakfast plate, a dish for breakfast.
- Show plate, i.e. flat plate size slightly larger than the dinner plate, given a good decoration for the show.

iii. Cups

- Soup cup, is a cup bowl with a larger size and has a handle on his right. Its diameter is about 10 cm.
- Coffee cup, is a coffee cup about 6 cm in diameter.
- tea cup, is a cup of tea with a diameter of 7 cm
- Demitasse cup, is a small cup with a diameter of 5 cm which is used to serve thick coffee.
- Egg dish, which is used to serve boiled eggs.

iv. Saucer

- Soup saucer, is a soup cup with a diameter of 14 cm.
- Tea saucer, is a tea cup dish with a diameter of 14 cm.
- Coffee saucer, is a coffee cup dish with a diameter of 14 cm.
- Demitasse saucer, is a demitasse cup mat with a diameter of 11 cm.
- Breakfast saucer, is a breakfast cup with a diameter of 14 cm.

v. Bowl

There are various types of bowls with their respective uses, such as Soup bowl, cereal bowl, finger bowl, sugar bowl, supreme bowl, butter bowl.

2.2.3. Material

In general the material used in the manufacture of ceramic products there are 3 types of clay, white gypsum and yellow gypsum. Clay is used for the manufacture of master products that are useful for mold making. Furthermore, to make the mold, the material used is white gypsum that is fast hardened and durable without going through the combustion process. After mold is formed, then do the casting process by using yellow gypsum.

a. Gypsum

Gypsum is one example of minerals with calcium levels that dominate in minerals. Gypsum is one of several minerals that is evaporated. Other examples of such minerals are carbonate, borate, nitrate, and sulfate. These minerals are deposited in the oceans, lakes, caves and in salt powder due to the concentration of ions by evaporation. Gypsum is used as mold and casting material because it has the properties that easily absorb water and dry quickly.

b. Sukabumi Clay

Clay with good quality found in many areas Sukabumi, West Java. This type of soil is used by PT.Nuansa Porselen Indonesia because it can be burned up to a temperature of 12500C, in accordance with the burning standards specified by the company. Characteristic of this clay is bright brown color, not brittle when dry, and easily formed.

2.2.4. ArtCAM 2015

ArtCAM 2015 is software produced by Delcam Company, designed to help design engineering in the design process of a product. ArtCAM has an easy-to-use feature for designing and producing a product quickly and easily. This software is also equipped with the ability to create a prototype quickly by using CAD data or commonly called Rapid Prototyping. ArtCAM is capable of performing tool path generation (CAM) for 3-axis CNC Milling machining process and 4-axis CNC Milling, with the integration of CAD and CAM processes so that product manufacturing process becomes faster and more efficient.

2.2.5. Reverse Engineering

Reverse Engineering is a basic concept for producing a part based on the original or physical model without the use of engineering drawings (Abella et al., 1994). Basically reverse engineering is used to analyze product capability, development, CAD data loss, product analysis, competition, learning, military purposes, duplicate, and destruction (Inder, P., & Richa, S. B., 2009). The main purpose of RE is the reconstruction of geometric objects consisting of a number of surfaces. If CAD data is incomplete then RE method is required. RE is a rapid and efficient product development method when the unavailability data CAD of a product (Sokovic et al 2006). Reverse Engineering has three basic stages: identification of object geometry information, point reconstruction, and application of CAD model to physical form. Reverse Engineering can shorten the processing time in the repair or manufacture of a product, assist in obtaining complete data of a product that previously had little or no data, and can analyze a physical product whether it is in line with CAD data (Parasdya, 2012). In the application of RE, can be done conventionally or using tools. Application by tool can use 3D scanner or Coordinate Measuring Machine (CMM) or conventional way by making vector through photo by tracing. Tracing is a way to follow the pattern on the picture / photo or it can be said to rebuild the existing image on a master image (Nugroho, 2016). From the current industry point of view, Reverse Engineering is regarded

as one of the engineering techniques that provide short time in the product development cycle (Vinesh et al., 2008) with tangible benefits on product customization.

2.2.6. Rapid Prototyping

Rapid Prototyping (RP) can be defined as the methods used to create a prototype model from starting part of a product or assembly rapidly using three-dimensional Aided design (CAD) computer data. Rapid Prototyping allows the visualization of a three-dimensional image into a native three-dimensional object that has volume. The first method of Rapid Prototyping is the Stereolithography method. After that developed various other methods that enable the making of prototype can be done quickly. Currently, the manufacture of prototype becomes a separate requirement on some companies in the effort to improve its products. Some of the reasons why Rapid Prototyping is so useful and necessary in the industrial world are:

i. Improve communication effectiveness in industrial environment or with consumer.
ii. Reduced production errors resulting in swelling of production costs.
iii. Reduce product development time.

Rapid Prototyping reduces product development time by providing opportunities for first correction of the product being made. By analyzing the prototype, the designer can correct some errors or inconsistencies in the design or provide engineering touches in improving the product. Current trends in the industrial world are the development of product variations, increased product complexity, and decreased production costs and delivery times.

2.2.7. Creative Method

Creative methods are design methods that aim to stimulate creative thinking by increasing the production of ideas, setting aside the mental barriers to creativity, or by extending the solution search area (Cross, 1994). Creative methods are divided into 2 types, namely Brainstorming and Sinektik methods.

a. Brainstorming

Brainstorming is a creative technique that seeks to resolve a particular problem by collecting ideas spontaneously from group members. The purpose of using Brainstorming is to capture as many alternative ideas as can be considered for

decision making. The benefits of Brainstorming are to identify problems, analyze situations, generate new ideas, analyze ideas, and determine alternative troubleshooting, plan steps and activities that will be done to fix problems.

b. Sinektik

This method aims to direct the spontaneous activity of thinking toward the exploration and transformation of design problems. Sinektik is a group activity that tries to build, combine, and develop ideas to provide creative solutions to design problems. Unlike Brainstorming which produces many ideas, in this method the group seeks to produce a specific solution